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Socioeconomic inequalities in infant temperament

The Generation R Study

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Abstract *Background* A low socioeconomic status (SES) has consistently been associated with behavioural problems during childhood. The studies of SES and behaviour in infants used temperament as a behavioural measure. However, these studies in younger children yielded inconsistent findings. Furthermore, they generally did not examine explanatory mechanisms underlying the association between SES and temperament. We investigated the association between SES and temperament in infancy. *Methods* The study was embedded in the Generation R study, a population-based cohort in The Netherlands. Maternal and paternal education, family income, and maternal occupational status were used as indicators of SES. At the age of 6 months, 4,055 mothers filled out six scales of the Infant Behaviour Questionnaire-Re-

vised. *Results* Lower SES was associated with more difficult infant temperament as measured by five of the six temperament dimensions (e.g. Fear: unadjusted z-score difference between lowest and highest education: 0.57 (95%CI: 0.43, 0.71)). Only the direction of the association between SES and Sadness was reversed. The effect of SES on Distress to Limitations, Recovery from Distress, and Duration of Orienting scores was largely explained by family stress and maternal psychological well-being. These covariates could not explain the higher levels of Activity and Fear nor the lower Sadness scores of infants from low SES groups. *Conclusions* SES inequalities in temperament were already present in six months old infants and could partially be explained by family stress and maternal psychological well-being. The results imply that socioeconomic inequalities in mental health in adults may have their origin early in life.

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Abbreviations SES: Socioeconomic status · IBQ-R: Infant behaviour questionnaire-revised · df: degrees of freedom · CI: confidence interval · SD: standard deviation

Introduction

Socioeconomic inequalities in mental health during childhood are well documented. Research within different age ranges has indicated that children from families with a low socioeconomic status (SES) exhibit higher rates of overall problem behaviour as measured by behaviour checklists than children from higher SES families [9, 23, 25, 34, 40, 56]. Similarly,

clinically diagnosed psychopathology is more prevalent among children from lower SES families, although the strength of this association varies by type of psychiatric disorder [2, 15]. The effects of SES were particularly consistent for disruptive behaviour disorders [15, 22], ADHD [49], and depression [10, 22], while an association between SES and, for example, pervasive developmental disorders is not evident [27]. The mechanisms through which SES influences children's psychosocial well-being are not completely understood; however, some mediating factors have been identified. Research has indicated that a young maternal age and single parenthood explain part of the association [2, 24].

The above mentioned studies were conducted in school-aged children. Research regarding socioeconomic inequalities in mental health of infants used temperament as a behavioural measure, which is one possible way to conceptualize early emotional differences. Temperamental traits are relatively stable across the lifespan [1, 50] and are shaped by both genetic and environmental factors [42, 48]. There are methodological difficulties when relating temperament dimensions to children's risk for psychopathology [16, 26]. However, several studies argued that temperamental difficulties predict later behavioural problems [8, 42, 48]. For instance, Schwartz et al. [51] reported that an inhibited temperament (subdued to and avoidant of novelty) in the second year of life predisposes children to social anxiety in adolescence. A difficult temperament in infancy is also associated with other adverse outcomes in childhood and adolescence (e.g. poor school achievement [32], language impairment [45], and problems with peers [47]).

Little research on the association between SES and infant temperament has been carried out. Most of these studies found no or minimal evidence of a socioeconomic gradient in infant temperament [33, 35, 39]; only Sameroff et al. [46] reported that infants of lower SES families had a more difficult temperament. Because of these contradictory findings, it has remained unclear whether socioeconomic differences in temperament are already present in infancy. Little attention has been paid to the explanatory mechanisms behind the association between SES and temperament. Probably, these mechanisms are at least partly similar to explanatory pathways through which SES influences behaviour of school-aged children, i.e. maternal age and single parenthood [2, 25];]. However, other risk factors of behavioural problems may also be involved. In a review, Campbell [6] concluded that many indicators of maternal psychological well-being and family stress are associated with problem behaviour in preschool children. Examples of these indicators are symptoms of maternal psychopathology and general malaise, marital dissatisfaction, and stressful life events in the past year. In the same review birth weight was listed as a biological risk factor of later behavioural problems

[6]. Furthermore, many other review studies indicated maternal smoking during pregnancy as a risk factor for child behavioural problems [14, 29]. As these risk factors of behavioural problems are associated with SES, they possibly explain the relation between SES and temperament.

The aim of the present study was to examine the association between socioeconomic status and temperament in infants six months of age. We analyzed the different indicators of SES, namely maternal and paternal education, maternal occupational status, and family income, separately, in order to study the differential effects of the SES components and obtain results easy to interpretate [3]. Furthermore, we explored the following possible explanatory mechanisms underlying this relation: sociodemographic characteristics (maternal age and marital status), family stress (long lasting difficulties and family functioning), and maternal psychological well-being (psychopathology, self-esteem and confidence in caretaking). We hypothesized that (1) a lower socioeconomic status is associated with less favourable temperament scores of the infants and (2) this effect is largely explained by sociodemographic characteristics, family stress, and maternal psychological well-being."

Methods

■ Design

This study was embedded in the Generation R Study, a population-based cohort study from fetal life until young adulthood [21]. Briefly, pregnant women living in the study area in Rotterdam, The Netherlands, with an expected delivery date between April 2002 and January 2006, were invited to participate. Written informed consent was obtained from all participants. The Medical Ethical Committee of the Erasmus Medical Centre, Rotterdam, has approved the study.

■ Population for analysis

Full consent for the postnatal phase of the Generation R Study was obtained from 7,295 infants and their mothers. Those without information on maternal education ($n = 662$) were excluded from the present study. Infants with missing data on temperament at six months, either due to logistic problems at our research centre ($n = 1,161$) or because of non-response ($n = 1,417$), were also excluded, yielding a sample size of 4,055 infants for the present analyses. The response rate for the temperament questionnaire was 74% (4,055/5,472). Due to missing data, the study population varies per indicator of SES. The study population consisted of 2001 boys and 2,054 girls with a mean age of 6.7 months. The ethnic breakdown of the sample was: 2,631 Dutch children, 395 Other Western children, and 1,027 children of non-Western background.

■ Socioeconomic status

Information on different indicators of SES was obtained by questionnaire during pregnancy. Maternal and paternal education were defined as the highest attained educational level and divided into five categories ranging from primary education only (I) to

university (V) [54]. Family income, defined by the total net monthly income of the household, was categorized as '<1,200 euros', '1,200–2,000 euros', and '>2,000 euros'. Maternal occupational status was coded from I (low occupation) to V (high occupation) following the method of the Dutch Central Bureau of Statistics [53].

■ Infant temperament

At the age of six months, infant temperament was assessed using an adapted version of the infant behaviour questionnaire-revised (IBQ-R) [17]. A detailed description of the changes has previously been described [44]. Briefly, we assessed six scales of the IBQ-R: Activity Level (e.g. movements of arms and legs); Distress to Limitations (e.g. fussing or crying while in caretaking activities); Duration of Orienting (e.g. attention to a single object for extended periods of time); Sadness (e.g. general low mood); Fear (e.g. startle or distress to novelty or sudden changes in stimulation); and Recovery from Distress (e.g. rate of recovery from general arousal; ease of falling asleep). Higher scores on the scales, except for Recovery from Distress, indicate a more difficult temperament. The 74 assessed items ask mothers to rate the frequency of certain behaviours in specified contexts across the previous week on a three-point scale (0 = never present, 1 = sometimes present, 2 = often present). The total score of a scale was defined as missing, if more than 25% of the items in a scale were not filled out. Internal consistencies for the adapted IBQ-R ranged from $\alpha = 0.70$ (Duration of Orienting) to $\alpha = 0.85$ (Fear), which is satisfactory and comparable to the internal consistencies of the original IBQ-R [17].

■ Covariates

On conceptual grounds, a distinction was made between confounders and mediators, two statistically identical concepts. The mediation hypothesis states that there is a causal relation between an independent, a third and dependent variable, while confounding does not necessarily imply a causal relationship between a third

and other variables [30]. Infant gender, age and ethnicity were considered as confounders, since they can bias the association, but are not on the causal pathway between socioeconomic status and infant temperament, in contrast to the other covariates under study.

Sociodemographic characteristics, family stress, maternal psychological well-being, maternal smoking during pregnancy and infant birth weight were studied as potential mediators. Information on the sociodemographic characteristics maternal age and marital status ('Married or cohabiting' and 'Single parenthood') was obtained by questionnaire. Family stress was assessed by questionnaire with the Long Lasting Difficulties checklist [20] and the General Functioning Scale of the Family Assessment Device [36]. Maternal psychological well-being included maternal psychopathology during pregnancy and again two months postpartum using the Brief Symptom Inventory, a validated self-report questionnaire which consists of positive and negative self-appraisal statements [12]. We evaluated global self-esteem with the Rosenberg Self-Esteem Scale [41]. The final measure of psychological well-being was the subscale Lack of Confidence in Caretaking of the Mother and Baby Scales [4]. Two months after birth of their child, the mothers filled out this scale, with lower scores denoting more confidence in looking after the baby.

■ Statistical analyses

The infants' temperament scores were z-standardized in the current study. The standardized differences between the mean temperament scores of different SES groups can thus be evaluated according to Cohen's criteria [11]. The Fear scores had a right skewed distribution and were therefore log transformed.

Linear regression was used to examine the association between SES and the six temperament scales. We conducted these analyses for each indicator of SES separately. The values presented in Tables 2, 3 and 4 reflect differences in IBQ-R scores between the highest SES group (reference group) and the other SES groups. The confounders infant age and ethnicity were included in the primary

Table 1 Characteristics of mothers and their infants according to level of maternal education

	Level of maternal education (n = 4,055)				
	V (highest) (n = 1,290)	IV (n = 970)	III (n = 1,146)	II (n = 406)	I (lowest) (n = 243)
Sociodemographic characteristics					
Age (years)	33.2 ± 3.2	31.8 ± 4.0***	29.9 ± 4.9***	28.3 ± 5.6***	28.4 ± 5.9***
Marital status (% single)	2.7	5.5**	12.7***	20.5***	22.3***
Family stress					
Long Lasting Difficulties (score)	1.6 ± 2.3	2.1 ± 2.7**	3.0 ± 3.7***	3.0 ± 3.5***	3.5 ± 4.2***
Family Assessment Device (score)	1.4 ± 0.4	1.5 ± 0.4**	1.6 ± 0.5***	1.7 ± 0.5***	1.8 ± 0.5***
Maternal psychological well-being					
Prenatal psychopathology (score)	0.16 ± 0.2	0.20 ± 0.2**	0.29 ± 0.4***	0.37 ± 0.4***	0.45 ± 0.5***
Postpartum psychopathology (score)	0.16 ± 0.2	0.21 ± 0.3**	0.27 ± 0.4***	0.28 ± 0.4***	0.38 ± 0.5***
Rosenberg Self-Esteem Scale (score)	4.5 ± 0.5	4.4 ± 0.5*	4.3 ± 0.6***	4.2 ± 0.6***	4.0 ± 0.7***
Lack of Confidence in Caretaking (score)	14.3 ± 10.4	13.9 ± 10.1	13.5 ± 10.2	11.8 ± 10.5***	12.5 ± 9.3*
Other covariates					
Smoking during pregnancy no (%)	87.9	81.5***	73.6***	57.0***	67.6***
Until pregnancy was known (%)	7.8	9.9	9.5	9.1	6.7
Continued during pregnancy (%)	4.3	9.9***	16.9***	33.9***	25.7***
Birth weight (g)	3,504 ± 559	3,460 ± 545	3,394 ± 575***	3,367 ± 567***	3,350 ± 541***
Confounders					
Gender (% boys)	48.5	49.4	50.3	49.3	49.0
Infant age (months)	6.6 ± 1.2	6.7 ± 1.4	6.7 ± 1.1	6.6 ± 1.2	6.8 ± 1.5*
Infant ethnicity					
Dutch (%)	76.5	72.2*	59.4***	54.4***	17.7***
Other western (%)	12.2	10.7	8.3**	5.4***	7.0*
Non-western (%)	11.3	17.0***	32.3***	40.1***	75.3***

Values are means ± SD for continuous variables and percentages for categorical variables

*P-value < 0.05, **P-value < 0.01, ***P-value < 0.001; ANOVA for continuous variables, χ^2 tests for categorical variables, vs. highest educational level (V)

Table 2 Level of maternal education and infant temperament, unadjusted and fully adjusted

Level of maternal education	<i>n</i> ^a	Activity level	Distress to limitations	Duration of orienting	Sadness	Fear ^b	Recovery from distress ^c
Age and ethnicity adjusted differences ^d							
V (highest)	1,290	0 (reference)	0 (reference)	0 (reference)	0 (reference)	0 (reference)	0 (reference)
IV	970	0.015 (0.041)	-0.066 (0.041)	0.056 (0.043)	-0.032 (0.043)	0.122 (0.041)**	0.017 (0.042)
III	1,146	0.217 (0.040)***	-0.006 (0.040)	0.138 (0.042)**	-0.097 (0.042)*	0.174 (0.040)***	-0.007 (0.041)
II	406	0.290 (0.056)***	-0.046 (0.056)	0.192 (0.058)**	-0.278 (0.058)***	0.240 (0.056)***	-0.049 (0.058)
I (lowest)	243	0.380 (0.073)***	0.172 (0.073)*	0.018 (0.076)	-0.155 (0.076)	0.570 (0.070)***	-0.175 (0.076)*
<i>P</i> for trend		<0.001	0.296	0.003	<0.001	<0.001	0.073
Fully adjusted differences ^e							
V (highest)	1,290	0 (reference)	0 (reference)	0 (reference)	0 (reference)	0 (reference)	0 (reference)
IV	970	-0.033 (0.040)	-0.097 (0.040)*	0.039 (0.043)	-0.053 (0.041)	0.093 (0.040)*	0.034 (0.041)
III	1,146	0.100 (0.041)*	-0.093 (0.041)*	0.098 (0.043)*	-0.162 (0.042)***	0.095 (0.041)*	0.050 (0.042)
II	406	0.123 (0.058)*	-0.167 (0.058)**	0.135 (0.062)*	-0.350 (0.059)***	0.136 (0.058)*	0.018 (0.060)
I (lowest)	243	0.213 (0.074)**	0.032 (0.074)	-0.033 (0.078)	-0.282 (0.075)***	0.434 (0.074)***	-0.092 (0.076)
<i>P</i> for trend		<0.001	0.101	0.129	<0.001	<0.001	0.863

Values are regression coefficients and reflect differences in z-scores (standard error) between a certain educational level and the reference group, i.e. highest educational level (V)

*Indicates a significant difference from the reference group, *P*-value < 0.05; ***P*-value < 0.01; ****P*-value < 0.001

^aGives number of infants per educational level that were included in the analyses of at least one temperament scale (maximum 10.7% less subjects per educational level)

^bFear was log transformed

^cIn contrast to all other scales, higher scores on Recovery from Distress indicate less temperamental problems

^dAdjusted for infant age and ethnicity

^eAdjusted for sociodemographic characteristics (maternal age, marital status), family stress (Long Lasting Difficulties, Family Assessment Device) and maternal psychological infant age and ethnicity, well-being (prenatal and postpartum psychopathology, Rosenberg Self-Esteem Scale, Lack of Confidence in Caretaking)

analyses. As gender did not meaningfully change the effect estimates, this covariate was not included as confounder. All fully adjusted associations were controlled for sociodemographic characteristics, family stress, as well as maternal psychological well-being. Adjustment for birth weight and smoking habits did not meaningfully change the effect estimates. Therefore, these covari-

ates were not included in the adjusted analyses. Stepwise adjustment is presented for two IBQ-R scales to illustrate the influence of specific covariates. We chose this statistical approach of regression adjustment and did not apply formal mediation criteria, as variables may be explanatory in the absence of significant associations with both the determinant and outcome [30].

Table 3 Indicators of socioeconomic status and infant temperament (all fully adjusted^d)

	<i>n</i> ^a	Activity level	Distress to limitations	Duration of orienting	Sadness	Fear ^b	Recovery from distress ^c
Level of paternal education							
V (highest)	1,076	0 (reference)	0 (reference)	0 (reference)	0 (reference)	0 (reference)	0 (reference)
IV	626	0.058 (0.048)	-0.106 (0.048)*	0.009 (0.050)	-0.102 (0.049)*	-0.013 (0.048)	-0.016 (0.049)
III	729	0.075 (0.047)	-0.179 (0.048)***	0.083 (0.050)	-0.178 (0.048)***	0.044 (0.048)	0.112 (0.048)*
II	329	0.207 (0.062)**	-0.204 (0.063)**	0.026 (0.066)	-0.195 (0.063)**	0.147 (0.063)*	0.130 (0.041)*
I (lowest)	155	0.261 (0.087)**	-0.062 (0.086)	0.016 (0.090)	-0.187 (0.088)*	0.273 (0.087)**	-0.156 (0.088)
<i>P</i> for trend		<0.001	0.001	0.397	<0.001	0.001	0.318
Maternal occupational status							
V (highest)	242	0 (reference)	0 (reference)	0 (reference)	0 (reference)	0 (reference)	0 (reference)
IV	870	-0.004 (0.069)	0.048 (0.070)	-0.018 (0.073)	0.008 (0.070)	0.006 (0.070)	-0.076 (0.070)
III	991	0.021 (0.068)	-0.092 (0.069)	0.042 (0.072)	-0.038 (0.070)	0.090 (0.069)	-0.031 (0.070)
II	838	0.152 (0.071)*	-0.071 (0.072)	0.076 (0.075)	-0.092 (0.073)	0.158 (0.072)*	-0.068 (0.073)
I (lowest)	136	0.406 (0.107)***	0.148 (0.108)	0.025 (0.114)	-0.039 (0.118)	0.326 (0.108)**	-0.154 (0.109)
<i>P</i> for trend		<0.001	0.252	0.130	0.091	<0.001	0.305
Family income							
>2,000 euros	2,738	0 (reference)	0 (reference)	0 (reference)	0 (reference)	0 (reference)	0 (reference)
1,200–2,000 euros	598	0.183 (0.046)**	0.020 (0.047)	0.024 (0.049)	-0.079 (0.048)	0.149 (0.047)**	-0.048 (0.048)
<1,200 euros	480	0.188 (0.062)**	0.063 (0.063)	-0.021 (0.066)	-0.269 (0.064)***	0.237 (0.063)***	-0.051 (0.065)
<i>P</i> for trend		<0.001	0.329	0.920	<0.001	<0.001	0.321

Values are regression coefficients and reflect differences in z-scores (standard error) between a certain SES category and the reference group

*Indicates a significant difference from the reference group, *P*-value < 0.05; ***P*-value < 0.01; ****P*-value < 0.001

^aGives number of infants per SES category that were included in the analyses of at least one temperament scale (maximum 10.3% less subjects per SES level)

^bFear was log transformed

^cIn contrast to all other scales, higher scores on Recovery from Distress indicate less temperamental problems

^dAdjusted for infant age and ethnicity, sociodemographic characteristics (maternal age, marital status), family stress (Long Lasting Difficulties, Family Assessment Device) and maternal psychological well-being (prenatal and postpartum psychopathology, Rosenberg Self-Esteem Scale, Lack of Confidence in Caretaking)

Table 4 Effect of adjusting for explanatory variables on the association between level of maternal education and two selected IBQ-R subscales

Level of maternal education	<i>n</i>	Basic model (BM): adjusted for infant age and ethnicity	BM additionally adjusted for sociodemographic characteristics	BM additionally adjusted for family stress	BM additionally adjusted for psychological well-being	Fully adjusted model
Activity level						
V (highest)	1,250	0 (reference)	0 (reference)	0 (reference)	0 (reference)	0 (reference)
IV	947	0.015 (0.041)	-0.023 (0.041)	-0.004 (0.041)	0.001 (0.040)	-0.033 (0.040)
III	1,116	0.217 (0.040)***	0.123 (0.041)**	0.167 (0.040)***	0.179 (0.040)***	0.100 (0.041)*
II	397	0.290 (0.056)***	0.147 (0.058)*	0.236 (0.056)***	0.240 (0.056)***	0.123 (0.058)*
I (lowest)	221	0.380 (0.073)***	0.272 (0.074)***	0.312 (0.074)***	0.297 (0.073)***	0.213 (0.074)**
<i>P</i> for trend		<0.001	<0.001	<0.001	<0.001	<0.001
Distress to limitations						
V (highest)	1,249	0 (reference)	0 (reference)	0 (reference)	0 (reference)	0 (reference)
IV	945	-0.066 (0.041)	-0.084 (0.041)*	-0.088 (0.041)*	-0.079 (0.040)	-0.097 (0.040)*
III	1,119	-0.006 (0.040)	-0.053 (0.041)	-0.070 (0.040)	-0.049 (0.040)	-0.093 (0.041)*
II	396	-0.046 (0.056)	-0.123 (0.058)*	-0.122 (0.056)*	-0.105 (0.056)	-0.167 (0.058)**
I (lowest)	227	0.172 (0.073)*	0.111 (0.074)	0.083 (0.073)	0.081 (0.073)	0.032 (0.074)
<i>P</i> for trend		0.296	0.706	0.400	0.582	0.101

Values are regression coefficients and reflect differences in z-scores (standard error) between a certain educational level and the reference group, i.e. highest education. Sociodemographic characteristics: maternal age, marital status. Family stress: Long Lasting Difficulties, Family Assessment Device. Psychological well-being: prenatal and postpartum psychopathology, Rosenberg Self-Esteem Scale, Lack of Confidence in Caretaking. Fully adjusted model: BM additionally adjusted for sociodemographic characteristics, family stress and maternal psychological well-being

*Indicates a significant difference from the reference group, *P*-value < 0.05; ***P*-value < 0.01; ****P*-value < 0.001

Multiple imputation (function *AregImpute* in *Spplus* 6.0) was applied to substitute missing data of the covariates, by using the relations between the variables in the dataset [19]. Because the substitution procedure was repeated five times, multiple imputation took into account the uncertainty of the imputed values. All statistical analyses were performed using Statistical Package of Social Sciences version 11.0 for Windows (SPSS Inc, Chicago, IL, USA) and *Spplus* 6.0 Professional Release 1.

■ Non-response analyses

Mothers with missing data on infant temperament (*n* = 2,578), either due to logistic problems or because of non-response, were compared with mothers who filled out the IBQ-R (*n* = 4,055). Data on temperament was more often missing (*n* = 2,578) in mothers who were lower educated ($\chi^2 = 259$; *df* = 4; *P* < 0.001), non-Western ($\chi^2 = 134$; *df* = 2; *P* < 0.001), single parent ($\chi^2 = 89$; *df* = 1; *P* < 0.001), and younger (*F*-test = 114; *df* = 1; *P* < 0.001) as compared to mothers who filled out the temperament questionnaire.

Results

Characteristics of the mothers and infants per educational category are presented in Table 1. The lowest educated mothers were younger as compared to mothers with the highest education (*F*-test = 159; *df* = 4; *P* < 0.001). They were also more often single ($\chi^2 = 128$; *df* = 1; *P* < 0.001), experienced higher levels of family stress (*F*-test = 58; *df* = 4; *P* < 0.001), and reported more Long Lasting Difficulties (*F*-test = 31; *df* = 4; *P* < 0.001) and psychopathological symptoms (prenatal: *F*-test = 60; *df* = 4; *P* < 0.001; postpartum: *F*-test = 28; *df* = 4; *P* < 0.001). Moreover, the infants of the lowest educated mothers were more often non-Dutch (82.3%) than infants of the highest educated mothers (23.5%; $\chi^2 = 276$; *df* = 1; *P* < 0.001).

Table 2 shows the association between maternal education and infant temperament scores. Mothers with low education as compared to mothers with high education had infants with a more difficult temperament, characterized by higher scores on Activity Level, Duration of Orienting, and Fear (*P* for trend < 0.001, 0.003 and < 0.001, respectively). The overall trend of SES inequalities in Distress to Limitations and Recovery from Distress was statistically non-significant (*P* for trend = 0.30 and = 0.07, respectively), although infants of the lowest educated mothers had worse scores than infants of the highest educated mothers on both scales (age and ethnicity adjusted differences: 0.172 (95%CI: 0.029, 0.315; *P* = 0.02) and -0.175 (95%CI: -0.323, -0.026; *P* = 0.02), respectively). These differences in Distress to Limitations and Recovery from Distress scores were no longer statistically significant after adjustment for sociodemographic characteristics, stress, and maternal psychological well-being (adjusted differences: 0.032 (95%CI: -0.113, 0.178; *P* = 0.67) and -0.092 (95%CI: -0.241, 0.057; *P* = 0.23), respectively). Educational differences in Duration of Orienting scores were also substantially reduced by adjusting, and did not reach significance anymore (*P* for trend = 0.13). The differences in Activity Level and Fear scores between infants of the highest and lowest educated mothers decreased only marginally after adjustment for the covariates (adjusted differences: 0.213 (95%CI: 0.068, 0.358; *P* = 0.004) and 0.434 (95%CI: 0.289, 0.579; *P* < 0.001), respectively). Compared to the other temperament dimensions, the direction of the association between education and Sadness was reversed: infants of higher educated mothers had higher Sadness scores than infants of lower educated mothers (*P* for trend < 0.001). The difference in Sadness scores

between infants of the highest and lowest educated mothers was even more marked after full adjustment (fully adjusted difference: -0.282 (95%CI: -0.429 , -0.135 ; $P < 0.001$)).

Table 3 presents the fully adjusted relation between different indicators of SES with infant temperament scores. Consistent with the results of the analyses with maternal education, both low maternal occupational status and low family income were associated with a more difficult infant temperament as measured with the dimensions Activity Level and Fear (P for trends < 0.001). Additionally, infants of families with a low income also had significantly lower scores on the Sadness scale (P for trend < 0.001). Maternal occupational status and family income were not related to the other temperamental dimensions. Again consistent with the other SES indicators, infants of low educated fathers had significantly higher scores on Activity Level and Fear as compared to infants of high educated fathers (fully adjusted differences: 0.261 (95%CI: 0.090 , 0.432 ; $P = 0.003$) and 0.273 (95%CI: 0.102 , 0.444 ; $P = 0.002$), respectively). In contrast to above two temperament scales, low paternal education was also associated with lower scores on Distress to Limitations and Sadness (P for trend 0.001 and < 0.001 , respectively), indicating less temperamental problems. Paternal educational level was not related to Duration of Orienting and Recovery from Distress (P for trend 0.397 and 0.318 , respectively).

To illustrate the explanatory effect of several variables on socioeconomic differences in temperament, stepwise covariate adjustment for two selected temperament dimensions is presented in Table 4. The explanatory effect of the covariates on these two dimensions are prototypical. Sociodemographic characteristics accounted for 35% ($(0.172 - 0.111) / 0.172$) of the difference in Distress to Limitations scores between infants of the highest and lowest educated mothers. In contrast, family stress and maternal psychological well-being explained a larger part of the score differences between infants of the highest and lowest educated mothers, 52 and 53%, respectively. The percentages add up to more than 100% due to overlap between different explanatory variables. The explanatory models of Activity Level scores followed a different pattern: family stress and maternal psychological well-being accounted for only 18 and 22%, respectively, while sociodemographic variables explained 28% of the differences between infants of the highest and lowest educated mothers.

Discussion

This population-based study showed that a lower socioeconomic status, as measured by various indicators, is associated with a more difficult tempera-

ment in 6 months old infants. The effect of SES on several dimensions of infant temperament could partially be explained by sociodemographic characteristics, family stress, and maternal psychological well-being.

A few studies have examined the association between SES and infant temperament in the past. Only Sameroff et al. [46] described, just like the present study, an unambiguous socioeconomic gradient across various temperament dimensions. Other researchers reported no association [33] or only exceptionally found a socioeconomic gradient and thus considered this as a chance finding [35, 39]. The discrepancy between these earlier findings and our results may be explained by the use of different temperament measures. The previous studies assessed temperament according to nine dimensions as postulated by Thomas and Chess [55], which substantially differ from the more recent IBQ-R scales with regard to composition and psychometric properties [43]. Furthermore, limited statistical power of the previous studies due to smaller sample sizes—between 96 and 772 infants—may also explain the inconsistent findings [33, 35, 39].

The results of the current study are, however, in line with reports of higher rates of problem behaviour and a higher prevalence of psychopathology in children of lower SES families as compared to those from a higher socioeconomic class [2, 9, 10, 15, 22, 23, 25, 34, 40, 49, 56]. Studies distinguishing between internalizing and externalizing behavioural problems reported a socioeconomic gradient for both dimensions. However, the SES gradient seems to be most substantial for externalizing problems [23, 25, 40]. The present study did not assess externalizing behaviour, though, research has indicated that temperamental difficulties in Activity Level, Distress to Limitations, and Recovery from Distress are predictive of later externalizing problems [8, 42, 48]. We reported that the SES inequalities in two out of these three temperament scales were explained by maternal psychological well-being and family stress. This result is interesting against the background of, for instance, evidence by Campbell [5] that both maternal depression and the experience of life-events are associated with externalizing problems. Apparently, adverse familial circumstances are already influential early in life, causing relatively high levels of distress in infants of lower SES families possibly predisposing to externalizing behavioural disorders.

Research indicates that young children with relatively high scores on Fear and Duration of Orienting are more likely to develop internalizing behavioural difficulties in later life [42, 48, 51]. Other studies have reported that the socioeconomic gradient is present in internalizing behavioural problems, even though this gradient is somewhat less substantial than for externalizing problems [23, 25, 40]. Although it was not the objective of our study to compare the different

temperament dimensions, it is noteworthy that we observed the strongest association between SES and infant temperament in the Fear dimension and not in the temperamental scales encompassed in the concept of externalizing behaviour. We carefully speculate that several explanations for this finding, which is seemingly in contrast to observations made by other study groups, are conceivable. Possibly, fear traits are already more prevalent early in life than externalizing features [13]. Alternatively, the discrepancy may also result from differences in psychometric properties, which were excellent for the Fear dimension in comparison with other IBQ-R scales, that are very good to moderate (e.g. Sadness) [17]. However, as temperament and behaviour remain different constructs, caution is needed in generalizing the results from the present study.

The Sadness dimension of the IBQ-R was introduced only recently [17]. Consequently, there are no studies of the relation between Sadness and later behavioural problems. Studies of infant temperament using different temperament measures found no association between SES and infants' mood, with the exception of one study [33, 35, 39, 46]. In contrast to our observations, Sameroff et al. [46] reported a more negative mood, instead of a more positive mood, among infants of lower SES families as compared to those from a higher socioeconomic class. Possibly, our observations are a chance finding. On the other hand, it is well known that symptoms of depression are not easily recognized in young children [7]. Finally, the association may also reflect the poor validity of the IBQ-R Sadness scale. Items like "Did your baby *seem sad* when the caregiver was gone for an unusually long period of time?" may be prone to subjective judgement. This notion is further supported by the low inter-rater agreement for Sadness as compared to other IBQ-R scales [17].

In contrast to other scales, the SES gradient in Activity Level and Fear were not explained in the present study. Several explanations are conceivable. Firstly, we were able to account for selected explanatory mechanisms only. Factors like nutrition and sleeping patterns could also explain part of the SES inequalities in temperament. A second explanation for the strong relation between SES and Activity Level and Fear scores may be embedded in the presumed constitutional basis of temperament. Estimates of heritability suggest that genetic differences among individuals account for approximately 20–60% of the variability in temperament within a population [48]. Therefore, it seems plausible that environmental factors and proxies for heritability, such as maternal psychological well-being, cannot explain all temperamental variation between SES groups. Genetic factors could explain the observed SES inequalities if gene variations are associated with temperament and are differentially distributed across SES groups. This is not implausible considering mechanisms of social

differentiation [22, 31]; several temperament and personality characteristics, such as extraversion and conscientiousness, are related to educational attainment and career success. Most likely, genetic variations underlying these characteristics are more prevalent among certain SES levels.

The present study examined the association between multiple indicators of SES and infant temperament, rather than a single indicator or composite indices of SES. Of the different SES measures, maternal occupational status seemed to have the least consistent relation with infant temperament. Apparently, having children diminishes the variation in maternal occupational status, making it a less good measure of SES. The effects of paternal education on Distress to Limitations and Recovery from Distress were less concordant with the results of other SES indicators. Not unlikely this reflects selection effects, as information on paternal education was available for much less participants. Overall, the different indicators of SES yielded the same results suggesting that maternal and paternal education, maternal occupational status, and family income represent approximately the same construct of SES inequality in The Netherlands.

■ Strengths and limitations

The strengths of the present study are the large number of participating infants and mothers, its population based design, and the information on numerous potential explanatory factors. However, our research has several limitations. Firstly, our non-response analyses indicated that data on infant temperament were more complete in infants of higher educated, non-single, and older mothers of Dutch ethnicity. This selective attrition resulted in an underrepresentation of infants of the most disadvantaged groups, who are at increased risk for temperamental problems [48]. This could have affected our results if the relation between SES and infant temperament differed between responding and non-responding families. Secondly, infant temperament was assessed using an adapted version of the IBQ-R. A major modification was the reduction of the answering categories to a three-point scale. This adaptation may have decreased power to detect statistically significant SES differences in temperament scores. Finally, the objectivity of a maternal report of infant temperament is discussed [18, 28, 52]. A maternal report of infant behaviour may reflect infant as well as maternal characteristics [28]. However, the IBQ-R was designed to reduce the influence of maternal bias by inquiring about concrete infant behaviours rather than asking mothers to make abstract judgements [17]. Moreover, maternal perceptions of infant behaviour tend to be predictive of later child characteristics [37, 38].

Conclusion

In conclusion, socioeconomic inequalities in temperament were identified early, in infants only six months of age. These inequalities in infant temperament are likely precursors of the socioeconomic gradient in behaviour in later life. Tackling SES inequalities in mental health should thus start with early interventions. As some of the factors that explained a more difficult temperament of infants in low SES families, like single motherhood, family stress, and maternal psychopathology, are either preventable or amendable, these could be targets of intervention strategies.

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